Intraoperatively Taken and Used Autologous Blood Transfusion; A Cost-Effective and Beneficial Way of Blood Transfusion in Cardiac Surgery: A Retrospective Clinical Trial

Eurasian Clinical and Analytical Medicine Original Research

Autologous blood transfusion

Fatma Ferda Kartufan[1], Kenan Abdurrahman Kara[2]

[1] Department of Anesthesia and Intensive Care

[2] Department of Cardiovascular Surgery, Yeditepe Univesity Hospital, Ataşehir, Istanbul, Turkey

Abstract

Aim: In recent years autologous blood transfusion (ABT) seems to be more beneficial than allograft blood transfusion in coronary artery bypass, major vascular surgery and other surgeries that have increased elective blood transfusion risk. This current retrospective controlled study aimed to show that the intraoperatively taken and transfused ABT (iABT) is practical, beneficial and cost-effective. Material and Method: Cardiac surgery patients were investigated from January 2017 to November 2018. Fifty-eight patients' clinical data were investigated. During the process; the cross-clamp time and the extracorporeal perfusion time, volume of blood loss, blood transfusions needed were investigated. During the intensive care unit hospitalization extubation, ICU hospitalization time, the volume of blood loss, blood transfusions needed were examined. Also, total hospitalization time, the total volume of blood loss, total blood transfusions required, 30 days of mortality and one year of mortality were investigated. Results: Fifty-eight patients' (23 female and 35 male) clinical data were investigated. ICU time was significantly shorter than the patients who were not transfused with iABT ($p<0.05$). Intraoperative, ICU stay, and total blood loss were significantly lower than who were not transfused with the iABT($p<0.05$). Discussion: This current study showed that the iABT is more beneficial than allograft blood and blood products transfusions. The iABT is related to less blood loss in operation and during the ICU stay, causing decreased risk of complications. According to less blood loss, fewer blood products transfusion is also a cost-effective benefit.

Keywords

Autologous Blood Transfusion; Cardiac Surgery; Preoperative Autologous Blood Donation; ICU; Restrictive Transfusion

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Corresponding Author: Kenan Abdurrahman Kara, Department of Cardiovascular Surgery, Yeditepe University Hospital, İçerenköy Mah. Hastane Sok. No:4,4/1 Ataşehir, İstanbul, Turkey.
GSM: +905300655225 · **F.:** +90 2164693796 · **E-Mail:** kenankaradoc@gmail.com · **Corresponding Author ORCID ID:** https://orcid.org/0000-0003-1295-7689

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Introduction

Cardiovascular operations appear to have a high risk of mortality and morbidity due to intraoperative bleeding problems, hemodilutional anemia, and the need for transfusion of blood and blood products. Reducing mortality and morbidity in cardiac surgery, especially intraoperative and post-operative transfusion-related ones is still our concern. Patients who underwent allograft packed red blood cell transfusion (PRBC) have been associated with morbidity, acute lung injury, acute kidney injury, stroke, myocardial infarction (MI), sepsis, surgical site infections, hemolytic transfusion reactions, prolonged ICU stay and hospitalization, and increased short- and long-term mortality [1-5]. Therefore, several indications have been established for the decision of blood transfusion primarily for patients who are intended to undergo cardiac surgical operations [6]. The guidelines recommend blood transfusion in the cardiac surgery patient group if the intraoperative anemia value diminishes to Hb 60-70 g/L [7,8]. In recent years, various studies have been performed about two different thresholds to determine the indication limits for blood transfusion; liberal (Hct>30%) and restrictive (Hct>24%). Restrictive transfusion (Hct>24%) protocol managed to reduce the PRBC use [9,10]. During cardiac surgery, the minimum Htc level is 21%. Hct <21% is associated with renal failure and neurocognitive dysfunction [11].

Autologous blood can be prepared as preoperative autologous blood donation (PABD) together with acute normovolemic hemodilution (PABD-ANH) or intraoperative autologous blood donation (iABD) together with ANH. There is still no certainty about the usage of PABD or iABD in cardiac surgery patients. Some studies suggest that patients eligible for PABD-ANH should be those with Hb >110g/L, Hct>33%, plt> 100x10 9 /L, normal coagulation results and normal cardio-pulmonary function. Each of PABD and iABD usage in patients with lung cancer and the positive data of the studies about non-affecting liver and blood coagulation factors make them both suitable for the use in cardiac surgery patients [12-14]. Intraoperative autologous blood transfusion (iABT) performed by iABD-ANH is more ideal for cardiac surgery patients; it has been widely used in clinical practice since 1946 because it is prepared by the perioperative anesthesiologist and it is performed using crystalloid or colloid replacement while monitoring vital functions with appropriate monitorization methods in the operating theatre [15].

This current retrospective controlled study aimed to show that the intraoperatively taken and transfused ABT (iABT) is practical, beneficial and cost-effective.

The hypothesis is that the usage of iABT in cardiac surgery will reduce intraoperative bleeding and post-operative total blood loss and decrease allograft blood and blood product transfusion and related morbidity and mortality while reducing ICU and hospital stay, and thus it is beneficial and cost-effective.

Material and Method

Ethical approval was obtained from Yeditepe University Clinical Trials Ethical Committee (No:929, 09/01/2019). Cardiac surgery patients were investigated from January 2017 to November 2018. According to the exclusion criteria of the study, 349 patients operated from peripheral vascular diseases, seven operated from emergent cardiac surgery, three managed from multiple cardiac operations and nine using anticoagulant treatment were excluded from 426 patients who had cardiovascular surgery. Fifty-eight patients were enrolled in the trial according to the following inclusion criteria: 18 years and over, planned elective cardiac surgery, no different surgical approaches during the same operation (e.g., no AVR+CABG), thoracic surgery not planned, no pulmonary hypertension (PAP>60mmHg), no post MI VSD, and none of the comorbidities such as anemia (hct<30%), low cardiac output (EF<30%), diabetes, renal failure, dialysis, cerebrovascular event, and no disease that could increase coagulopathy (hepatic failure, factor 5-8-9-10 deficiency, Vit K deficiency).

All clinical perioperative and postoperative data until discharge were investigated from the patients' records retrospectively. During the operation, the cross-clamp time and the extracorporeal perfusion time, the volume of blood loss, the volume of blood and blood products transfused intraoperatively were investigated as perioperative data. ICU length of stay, extubation time in ICU and the volume of blood loss, the volume of blood and blood products transfused postoperatively were investigated. Also, total hospitalization time, the total volume of blood loss, the total volume of blood and blood products transfused, 30 days of mortality and one year of mortality were investigated.

Minimum-maximum, mean and standard deviation values were included in descriptive statistics. The independent samples t-test to compare volumes of blood loss and transfused blood volumes according to intraoperatively taken ABT usage and the Chi-Square test for comparing complications related to the operation and bleeding according to iABT usage were used. SPSS 22.0 programme was used for analysis. A p-value of less than 0.05 was considered to be statistically significant.

Results

Fifty-eight patients' (23 female and 35 male) clinical data were investigated. Demographic data of the patients are shown in Table 1. The iABT usage of the patients and the complications occurred in the cardiac surgery operations are shown in Table 2. Complications were significantly decreased according to the iABT usage (p=0.029).

Only one complication occurred in CABG in 20 of 35 males who were taken iABT in the surgery. Four of the 15 male patients not taken iABT in CABG had several complications. Seven of 23 women had no complications associated with iABT during surgery. Four of the 16 female patients not taken iABT in ASD, MVR, and AVR operations had several complications.

There was no significance between iABT and cross-clamp time, extubation time and hospital stay (p>0.05) but significance was detected on the decreased pump time, and ICU stay related to iABT (p= 0.021 and p= 0.007, respectively).

The volumes of perioperative blood loss, ICU blood loss, and the total blood loss were significantly lower than those who were not transfused with iABT (p=0.005, p=0.026, p=0.002, respectively) (Table 3).

The intraoperative volume of blood transfused as whole blood (WB), and PRBC transfusion was significantly lower in the patients who were transfused with iABT (p=0.002, p=0.034 respectively). The volume of blood transfused intraoperatively as fresh frozen plasma (FFP), suspension of blood platelets (sBP) and cryoprecipitate was not significant (p>0.05).

During the ICU stay the volume of blood transfused as WB, and PRBC, FFP transfusion were significantly lower (p=0,012, p= 0,024, p= 0,016 respectively). The volume of blood transfused intraoperatively as sBP and cryoprecipitate was not significant (p>0,05) (Table 4).

The total volume of the blood transfused as WB, and PRBC and FFP transfusion was significantly lower in the patients who used iABT (p=0,000, p=0,003, p=0,038 respectively). The volume of blood transfused as sBP and cryoprecipitate was not significant (p= 0,054, p>0,05) (Table 4).

There was not any occurrence of in-hospital, 30-days or long-term mortality.

Discussion

The most important finding of this study is that the iABT administered to the patient reduces intraoperative and ICU blood loss and thus total

Table 1. Demographic data of the patients

	Sex (N - %)	Mean ±SD	Min-Max
Age (years)	Male (n:35 - 60.34%)	60.83±10,50	42.0- 75.0
	Female (n:23 - 39.66%)	60.95±14,31	19.8-76.0
	Total (n:58 - 100%)	60.88±12,05	19.8-76.0
Height (cm)	Male (n:35 - 60.34%)	172.17±5.48	160-185
	Female (n:23 - 39.66%)	159.39±7.42	146-175
	Total (n:58 - 100%)	167.10±8.88	146-185
Weight (kg)	Male (n:35 - 60.34%)	86.63±12.02	66-124
	Female (n:23 - 39.66%)	67.78±15.17	51-98
	Total (n:58 - 100%)	79.16±15.17	51-124
	iABT/AllograftBT (N - %)	Mean ±SD	Min-Max
Cross-c-lamp time (min)	iABT	74.70±20.16	35-125
	AllograftBT	73.06±23.46	35-120
	Total (n:58 - 100%)	73.83±21.81	35-125
Pump time (min)	iABT	120.56±28.30	70-190
	AllograftBT	129.61±38.15	70-220
	Total (n:58 - 100%)	125.40±33.94	70-220
Extubation time (hr)	iABT	12.44±7,84	5.0-45.0
	AllograftBT	15.52±11,37	7.0-43.0
	Total (n:58 - 100%)	14.09±9,92	5.0-45.0
ICU stay (hr)	iABT	52.89±20.32	24-96
	AllograftBT	106.84±101.04	48-528
	Total (n:58 - 100%)	81.72±79.34	24-528
Hospitalization (hr)	iABT	177.78±76.84	96.00-504.00
	AllograftBT	216.00±130.28	120.00-792.00
	Total (n:58 - 100%)	198.21±109.53	96.00-792.00

N:number, Min: minimum, Max: maximum, SD: standard deviation, kg:kilogram, m:meter, cm: centimeter,min: minute, hr: hour. ICU: Intensive care unit, BT:Blood transfusion, iABT: intraoperative autologous blood transfusion

Table 2. Cardiac Surgery and iABT related Complications and Mortality

CARDIAC SURGERY	Blood Transfusion(BT)	N	Complications (N)-explanations	Mortality(N)
ASD	iABT	1		0
	AllograftBT	1	1-postoperative hypotension circulation collapse- emergency sternotomy	0
AVR	iABT	1		0
	AllograftBT	0		0
AVR-REV	iABT	0		0
	AllograftBT	1	1 perioperative bleeding	0
BENTALL	iABT	1		0
	AllograftBT	0		0
MVR	iABT	2		0
	AllograftBT	7	1 perioperative bleeding 1-hypotension, tamponade-iabp-dialysis	0
MVR-REV	iABT	0		0
	AllograftBT	1		0
CABG	iABT	22	1-tamponade	0
	AllograftBT	21	1-tamponade-dialysis-right transibitial amputation-trakeostomy 1-iabp-amputation Left foot 1.phalanx 2-postoperative bleeding	0
TOTAL	iABT	27	1	0
	AllograftBT	31	8	0

ASD: atrial septal defect, AVR: aortic valve replacement, AVR-REV: aortic valve replacement - revision, MVR: mitral valve replacement, MVR-REV: mitral valve replacement-revision , CABG: coronary artery bypass grafting, iABT: intraoperative autologous blood transfusion, BT: blood transfusion , N: number

Table 3. The volume of blood loss during operation, ICU stay and hospital stay

Duration of blood loss	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		p
			Lower	Upper	
Perioperative	188.65	63.69	60.34	316.96	0.005*
ICU stay	272.71	119.09	34.03	511.39	0.026
Hospital stay	488.07	146.11	194.52	781.61	0.002*

Independent t test, Bold: p<0.05, *:p<0.01
ICU: Intensive care unit

blood loss. Furthermore, it is true that iABT administration significantly reduces the total WB, total PRBC and total FFP volume given to the patient and consequently leads to a decrease in complications.

Although a review on autologous blood transfusion provides evidence that preoperative autologous blood donation reduces the incidence of postoperative complications in cardiac surgery, hemodynamic and vital function monitoring should be conducted appropriately during donation due to the specific nature of cardiac surgery patients considering the studies suggesting that preoperative autologous blood donation, particularly in cardiac surgery patients under 18 years of age, increases the emergence of vasovagal reactions three times more than adult patients [16,17]. Also, preoperative autologous blood donation cannot be performed to the patients who will have cardiac surgery emergently. Not all patients planned to undergo cardiac surgery under elective conditions are eligible for the operation, and operation can be delayed in some cases. Therefore, preoperative autologous blood donation can turn into a disadvantage instead of an advantage in these patients due to the blood being held for a long time and a large number of active components and their activities being disrupted [12].

The iABT method in autologous blood donation for cardiac surgery patients has been considered and appropriated in our clinic because it is taken from a patient along with invasive monitorization applied after anesthesia induction in the operating theatre; it ensures hemodynamic control. Crystalloid and/or colloid replacement is performed under the supervision of anesthesiologist if necessary; the blood is not held for a long time and it is an easy method. Although there are studies in large patient groups stating that intraoperative autologous blood donation and hemodilution of the patient require maintaining a Hct level between 15% and 19% and it is safe and feasible with proper cooling and anesthetic management for cardiopulmonary bypass operation without any change in blood pressure, CVP and heart rate and blood gas values, our clinic adopted the restrictive blood transfusion protocol as a Hct <21% is associated with renal failure and neurocognitive dysfunction [11,18].

There are many recent studies on autologous blood transfusion. The study results vary. Studies like that of Helm et al. claim that autologous

Table 4. Volumes and types of blood transfused perioperatively, during ICU stay and total hospital stay

Duration of Blood transfused	Types of blood products transfused	Mean Difference	Std. Error Difference	Lower	95% Confidence Interval of the Difference Upper	p
Hospital stay	WB	301.55317	80.29919	140.31369	462.79265	0.000*
	PRBC	854.49223	269.02169	310.28388	1398.70058	0.003*
	FFP	247.09677	115.20202	14.21239	479.98115	0.038
	sBP	92.89128	47.04029	-1.48431	187.26687	0.054
	cryoprecipitate	12.90323	12.90323	-13.44868	39.25513	0.325
Perioperative	WB	237.03704	70.98110	94.76617	379.30791	0.002*
	PRBC	316.16607	143.22760	25.78937	606.54277	0.034
	FFP	62.58065	50.06705	-37.91154	163.07283	0.217
	sBP	57.34767	34.64466	-12.13994	126.83528	0.104
ICU stay	WB	77.41935	28.85249	18.49471	136.34400	0.012
	PRBC	511.00358	218.39159	70.22845	951.77871	0.024
	FFP	220.64516	87.48524	43.96694	397.32338	0.016
	sBP	35.54361	29.44512	-23.51061	94.59782	0.233
	cryoprecipitate	12.90323	12.90323	-13.44868	39.25513	0.325

Independent t test, Bold: p<0.05, *:p<0.01
ICU: Intensive care unit, WB: whole blood, PRBC: packed red blood cell, FFP: fresh frozen plasma, sBP: suspension of blood platelets

blood transfusion does not make a difference concerning postoperative blood loss in cardiac surgery patients [19]. However, studies are recommending autologous fresh whole blood transfusion as an alternative treatment method to reduce in-hospital and 30-day mortality rates as it reduces extubation time, ICU stay, hospital stay as well as blood loss, allograft blood transfusion and postoperative complications resulting from blood transfusions or the mentioned causes [20-23]. This current study has parallel positive findings with those studies discussed above, such as perioperatively, postoperatively and in-hospital stay decreased blood volume loss, impaired transfusion of WB and packed RBC perioperatively, impaired transfusion of WB, packed RBC and FFP in ICU stay and during whole hospital stay that provides reduced risk of complication occurrence and earlier transportation to the patient rooms from ICU unit.

The limitations of our study are as follows: not being prospective, being single-center, and our inability to evaluate 30-day and long-term mortality because there was no mortality in our study group and the small number in the study group due to limited inclusion criteria. The strengths of our study include the calculation of blood losses and transfused blood as volumes, making our study statistically robust.

Further studies, especially multi-center studies are needed mostly for morbidity and long term mortality and the minimization of allograft blood transfusion related complications in large study groups.

Conclusion

This current study showed that the iABT is more beneficial than allograft blood and blood products transfusions. The iABT is related to a decreased volume of total blood loss including both in operation and during the ICU stay, and also reduced allograft blood and blood products transfusion (mainly red blood cell transfusion) that provides a reduced risk of complication occurrence, achieving shortened ICU stay. According to all of the positive effects mentioned above, the iABT is also seems to be cost-effective.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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